

ILLOWAY (H.)

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HEAT-STROKE

(THERMIC FEVER)

IN INFANTS.

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presented by the author -



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Heat Stroke (Thermic Fever) in Infants.

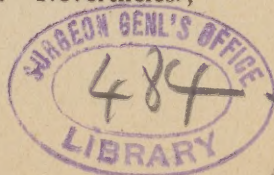
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Heat Stroke, as an effect of atmospheric heat, is unknown in the category of infantile diseases; in fact, atmospheric heat as an etiological factor in the production of pathological conditions has as yet no place—that is, an independent place as a factor *per se*—in the treatises on pædiatrics.

Certain clinical facts that have come under my observation have convinced me that summer heat as an etiological factor deserves greater consideration than it has hitherto received, and furthermore that heat stroke is one of the pathological states that may be produced by it.

CASE I.—On the morning of September 1, 1874, I received a note from a colleague requesting me to attend for him baby M. as he had to leave the city for a day. I called that morning and found my patient a baby one year old, of good size and in good flesh; still nursed at the breast. The history of its illness was: The afternoon of the previous day the baby was seized with vomiting and diarrhoea; the family physician was called and prescribed neutral mixture $\mathfrak{Z}ii.$, laudanum 12 drops, M. Sig., one teaspoonful to be taken every two hours. Of this mixture the patient had taken about half. When I saw the patient she was in the following condition: Pulse feeble, almost imperceptible; the eyes covered with a film; the respiration gasping and shallow; the muscles of the jaw, buccinator and masseter, were firmly contracted; the occiput and whole body very hot to the touch; the face was purplish and presented the appearance of a person in asphyxia. I did not believe that anything that medicine could do would save the child. Nevertheless,



to satisfy the parents, who clamored that something be done, and in accordance with the old adage "that while there is life there is hope," I directed an ice-bag to be applied to the head and flannel cloths wrung out of hot mustard water to be applied to the feet. I gave it at the same time about two teaspoonfuls—in very minute quantity at a time, for the reason that there appeared to be no voluntary deglutition any more—of a mixture of three parts water and one part whisky. I also prescribed a few grains of hydrate of chloral, which I directed to be administered gradatim—this with a view of relaxing the stiffened muscles of the jaw.

I returned at 1 P.M.; no better. The medicine was not taken, as the child did not swallow. I returned at 3 P.M. The thermometer placed in the axilla indicated 106° F.; the skin was dry and hot; the respiration shallow and less frequent; there was complete loss of consciousness. I had the child placed in a warm bath, the ice-bag being kept upon the head. For the time being it seemed to do some good, but after the child was out of the bath for a few moments it relapsed into its former condition.

I therefore directed the naked child to be wrapped in a sheet wrung out of cold cistern water (having a temperature about 70° F.). This was done, the child placed in its cradle and covered with a comfort; seven minutes by the clock the sheet was hot and almost dry; it was removed and replaced by a fresh one.

It was wonderful to observe the change in the child the moment it was wrapped in the wet sheet. There seemed to come over it a feeling of *bien aise*; the respirations became deeper and more regular, and it presented the appearance of being in a tranquil sleep; the moment the sheet became warm the baby grew restless, would roll around, groan, the respirations would become gasping, to be relieved by the application of a freshly wrung-out sheet. This application of the wet pack was continued all the afternoon and night. At 11 P.M. the thermometer recorded 103° F. The sheets would now remain cool for over half an hour. This procedure was continued regularly all night, the mother doing her duty very attentively and intelligently. The next morning at 8 A.M. the thermometer in the axilla indicated 101° F. The child still appeared unconscious. Treatment continued. At 1 P.M. the child's temperature was 99 $\frac{3}{4}$ °. At 4 P.M. I was again at the house with the family physician, who had just returned. Just as I was

about to place the thermometer in the axilla the baby rose up in its cradle and called "Mamma." Consciousness was restored. The wet pack was now discarded, and treatment continued with quinine in small doses and strong coffee. On the 4th of September the child was discharged well.

Remarks.—When I first saw the patient I did not take the temperature because, as I stated above, the child seemed doomed. On my return at 3 P.M., finding the child still living, I applied the thermometer in order to indicate to me, in my perplexity, a line of treatment ⁽¹⁾.

CASE 2.—June 25, 1885, I was called to see baby V., about ten months old, well developed and in fair flesh; nurses at the breast. It was taken ill in the night with vomiting and diarrhœa. At the time of my visit (10 A.M.) I found the baby lying in the cradle with eyes half closed, moaning occasionally, and rather restless. Considerable heat of head; temperature in axilla 104° F. Vomits whenever it nurses; diarrhœa not so marked as at the outset. I prescribed a mixture of spirits Mindereri, spirit. nitr. dulc. and a minute quantity of tinct. aconit. rad. to be administered in fifteen-drop doses every hour. In the afternoon I was told by the mother that the child had vomited the medicine every time it had been administered; it also vomited after nursing. Its temperature appeared higher. I directed the mother to omit the medicine for a few hours, and not even nurse it during that period; to sponge it off at intervals with lukewarm water and vinegar. About 9 P.M. I saw the little patient again. The temperature outside, which had been very hot all day, had become suffocating in the evening; the atmosphere was heavy; there was rain in the air. The temperature of the baby, despite repeated spongings, had risen to 105 $\frac{3}{4}$ ° F. There was great heat of head, great restlessness and hurried respiration; markedly rapid movement of the alæ nasi; great rapidity of pulse.

I directed the child to be placed in the cold, wet pack, after the manner described in Case 1, and staid for a time to see that it was properly done. The effect was marked; the restlessness disappeared at once; the respiration became tranquil and the child fell into a calm sleep. As soon as the pack became warm the restlessness and hurried respiration

(1) This case was reported (essentially as here), with others, in a paper entitled "Hydrotherapeutics" read by me before the Cincinnati Academy of Medicine, November 12, 1876, printed in the *Lancet and Observer*, June, 1877. Reprint. It is re-reported here to reinforce the chain of clinical evidence of which it forms the strongest link.

returned, to disappear immediately upon the renewal of the pack. The wet pack was continued all night. Next morning at 9 A.M. temperature in axilla $101\frac{1}{2}^{\circ}$ F. The baby had nursed twice in the night, and had retained the milk. No diarrhoea since last night. The wet cloths to be continued till noon. 1 P.M., temperature almost normal and pack discontinued.

No return of the unfavorable manifestations. The child was discharged as well the next morning.

These two cases are undoubtedly cases of *heat stroke—thermic fever* (*Ueberhitzung*), and this is clearly demonstrated by a careful consideration of the symptomatology and a comparison of the same with the phenomena obtained in experimental investigations as well as by the success of the therapeutic measures resorted to.

In the various experimental studies as to the effects of high temperatures upon animals, a series of phenomena, manifesting themselves progressively as the temperature of the animals rose, was observed. These may be summed up in the order of their appearance as follows: Nausea; Dyspnoea and cardiac irregularity with greatly increased rapidity of pulse; Heat rigidity (*wärmestarre*). In the experiments made by Krishaber upon himself, he noted, as a consequence of the rapid elevation of temperature: Increased rapidity of heart's action (pulse rising from 75 to 160); Headache; Malaise (*unbehagen*); Nausea ⁽¹⁾; phenomena exactly like those observed in the experimental studies on animals.

That in Case 1 we have a case of heat-stroke will hardly be questioned, the whole array of symptoms as described in the history pointing thereto. We have the initiatory phenomena, the progression in gravity, until at the time when I saw the case we have the climax reached, a state of asphyxia due to the diminished exhalation of carbon-dioxide and great destruction of oxygen; an effect observed by Litten in his experimental studies. In addition thereto, we note the setting in of heat rigidity, confined, it is true, to a limited number of muscles, but still manifesting itself. It is a typical case. ⁽²⁾

Case 2, though not so marked as the first, is, nevertheless, also one of heat-stroke. In this case, observed from an

(1) Litten: "Ueber die Einwirkung erhöhter Temperaturen auf den thierischen Organismus." *Virchow's Archiv*, Band 70.

Naunyn: "Fieber u Kaltwasserbehandlung." *Archiv. f. Eperim. Patholog. u Pharmacol*, Band 18.

(2) Consult the various text-books: Strumpell, Quain's Dictionary of Medicine, etc.

early period, we note the increase in the gravity of the phenomena running parallel with the exaltation of the temperature. We have the initiatory nausea as shown by the vomiting that ensued when anything was administered by mouth or when the patient nursed; then the setting in of the heat dyspnoea, by the frequency of the respirations; the great rapidity of the heart's action as indicated by the pulse; the great restlessness, due partly to the dyspnoea and partly to the cerebral irritation, equivalent in the infant to the headache observed in the experimental study in adults.

Taking both cases together, we have a striking clinical verification of the phenomena noted in the experimental studies, the second case presenting the phenomena as they gradually develop, and the first illustrating the climax.

Two symptoms recorded in the history of our cases—viz.: vomiting and diarrhoea—are as yet unaccounted for in our study of these cases, similar phenomena not being recorded in the experimental studies referred to. A moment's thought, however, will convince us that they have the same etiological relation as the other phenomena, and that they form part of the history of heat-stroke.

We have the nausea as a marked manifestation of the overheating process, and certainly from nausea to vomiting is but a short step, especially in the infant that can not speak, to whom food is always tendered at longer or shorter intervals, and who will take this food impelled thereto by the thirst accompanying the thermic process; the result of such administration of food in the state of nausea being the immediate rejection of the same.

It is indeed so common a fact that an infant should vomit with any sudden and marked elevation of temperature that it really needed no further elucidation here.

There is, however, further and more direct proof in the fact that vomiting has been noted as one of the phenomena of heat-stroke in adults. ⁽¹⁾

It is an established fact that with a febrile elevation of temperature the digestive power of the stomach is greatly depressed, and much more so in the pathological state known as heat-stroke, where even lesser degrees of temperature elevation provoke graver disturbances than the more marked elevations of fevers. ⁽²⁾ Now, part of the food in the infant's stomach passing undigested into the intestinal canal, and

(1) Quain's Dictionary of Medicine, art. Sunstroke, et seq.

(2) Naunyn, Loc. Cit.

there acting as an irritant, excites abnormal peristaltic movement and a diarrhoeal discharge is produced.

But still another factor may be invoked here, namely: Stimulation of the vagus center. It has been experimentally demonstrated by Cyon that a sudden elevation of the temperature of the blood circulating in the brain (from 34° to 48° C.) causes slowing of the heart's action (from 23 to 5 in ten seconds) by stimulation of the vagus center in the medulla. ⁽¹⁾

Though ordinarily in cases of heat-stroke we have no such sudden great elevation of temperature as the experimental one above mentioned, still it is presumable that even a lesser degree of elevation would produce a certain amount of stimulation of the vagus center. This is confirmed by the increased frequency of respiration observed with less marked temperature elevations—an increase undoubtedly at first produced by stimulation of the vagus center. And it is more than probable that even minor degrees of temperature exaltation occurring quickly will have such an effect on the very mobile and impressionable nervous system of the infant.

It is well known that stimulation of the vagus excites peristaltic movements in the small intestines. ⁽²⁾ Now, this stimulation of the vagus, alone or superadded to the irritation produced by the undigested food, excites such rapid peristalsis as to give to the evacuations the diarrhoeal character.

Taking the foregoing facts into consideration we are justified in considering the vomiting and diarrhoea, mentioned in the histories of the cases above related, as part and parcel of the symptomatology of heat-stroke.

CASE 3.—Baby K. In the summer of 1885 I was called one night at 10 P.M. to see baby K., about one year old, and bottle fed. The family lived in a long, one-story frame building, the front and larger part of which was kept as a furniture store and the remainder as the living-rooms. The building was closed in on both sides, and all the ventilation and fresh air came through the front doors. In the afternoon he had been seized with vomiting; he threw up everything that was given him. Later on he became very restless, would not lie down in his cradle, and wanted to be carried about on his mother's arm. Being very much fatigued that evening—it was an exceedingly warm night,

(1) Naunyn, Loc. Cit.

(2) Foster's Physiology, Ed. 1880, p. 380.

not a breath of air stirring—and the room being very hot, the burning lamps adding to the heat, so that I felt stifled, I made but a careless examination, and prescribed a mixture containing hydrate of chloral.

Next morning on my visit the mother informed me that she had administered several doses of the medicine, but that the child had immediately vomited them; that it had been very restless all night, and would not leave her arm. I now examined the child carefully. I observed that as it was held in a sitting posture on its mother's arm it constantly inclined its head toward the head and shoulder of the mother, as if its head were heavy and difficult to support. The head was hot to the touch; the eyes were dull; the face was pale; the temperature, in axilla, 103° F.; the pulse about 130. Taking all these phenomena into consideration, I concluded that I had a case of incipient brain trouble before me. Whilst reflecting upon the therapeutic indications it occurred to me that perhaps the heat of the room, as I had experienced it, might be responsible for the illness of the child. I therefore directed that cloths wrung out of ice water be applied to the child's head. No medicine to be given it and no food; that in a few hours, after the steady application of the cold cloths upon the head, it be given every half hour a teaspoonful of a mixture of equal parts of lime water and milk; if this were well borne, then after further four or five hours the dose was to be increased to two teaspoonfuls.

The next morning I found my little patient much better. The child looked brighter; it held its head better; it did not vomit any more, and had rested much better in the night. Temperature, 101° F.; pulse much reduced in frequency. I directed the treatment to be continued; advised a slight increase in the quantity of milk and lime water, but positively forbade feeding with the bottle. The following morning I found my patient well, but weak. The baby had slept very well in the night, and in the morning it had taken its bottle well—the mother tried it, giving, however, but half the usual quantity—and with some avidity. Its temperature was normal, and it held up its head well.

At first glance it might appear that I had incorporated into this paper a case of beginning meningitis. It needs no long elucidation, however, to demonstrate clearly that this is not so, and that the case properly belongs in the category

under consideration. We have no prodromal history. The child is well up to the day upon which I made my first visit. There is no history of convulsions; no history of twitchings. There are no ocular phenomena nor, to say the least, any drowsiness. In fact, the major part of the symptoms that go to make up the history of meningitis are wanting.

But what do we have? We have a history of sudden invasion. We have vomiting of everything that is administered, evidence of a state of nausea; we have general elevation of temperature, and that to a marked degree; we have great restlessness; symptoms which, taking the season and surroundings into consideration, all point to one morbid state, namely, heat stroke.

It is true that the attitude of the child, manifestations of the greatest importance in infantile symptomatology, seemed to point chiefly to the head as the seat of morbid processes, but, cerebral disturbance, as has already been said above, is one of the features of heat stroke even in its earlier stages. Obernier states that in heat stroke with a temperature rise of only to 102–103° F., painful malaise (*schmerzhaftes unbehagen*), headache and rapid pulse (132) are present. ⁽¹⁾

Furthermore, it is more than probable that the greater prominence of the head symptoms in this case is due to the fact that the greatest heat was reflected from the ceiling, as described in the history, and acted with full force upon the comparatively bare head of the infant, thus producing a greater amount of cerebral irritation than if the heat had been more equably distributed, and its influence exerted upon the whole body.

Etiology.—As seen from the histories, nothing extraordinary occurred to these infants to which the heat stroke could be directly attributed. There was no undue exposure to the sun or to excessive artificial heat. There remains, therefore, as the sole etiological factor, the atmospheric heat as created in the apartments, wherein they dwelt, by the season, *i. e.*, the summer. It is true, however, that the habitations of these infants were of such character that even a not excessively hot summer would produce therein a degree of heat that might be readily productive of thermic fever in infants, who are so very susceptible to heat.

Case No. 1 lived on the second floor of a two-story frame building located in a narrow street at the foot of a hill, with

(1) Naunyn, Loc. Cit. p. 59.

a tier of streets rising above it. The first floor was occupied by a bakery. Though the two rooms on the second floor were comparatively large, there was no ventilation; the windows of the front room opened on the narrow street with much higher houses on the opposite side; the window of the rear room opened into a small court with a large frame building at the farther end, and beyond this there towered, one above the other, the houses on the tier of streets on the hill. The front room was divided off from the rear room by a full partition wall, communicating only by a narrow door, so that a free current of air was an impossibility. In the rear room all the cooking for the family, and all the service requiring fire, was done; the front room served as a bedroom for father, mother and four children. Owing to the narrowness of the street the front shutters had to be kept closed at night. To this must be superadded the location of the rooms—very near the roof, only separated from it by a small space—and the heat created in the building by the bakery.

Case 2.—The family lived in a small back room of a tenement with door and window on same side opening onto a close court. This room was on the ground floor, and served as a kitchen and bedroom for the mother and four children, and from the miscellaneous character of the inhabitants of the building and the fact that a passage way, which was always open, led into the court from the street, they were compelled to keep everything closed even on the hottest night.

The habitation of Case 3 has been fully described in the history.

That heat stroke can occur in overheated rooms is so well known and so well established a fact that it needs no further proof here. ⁽¹⁾

TREATMENT.—It would be a work of supererogation now, after the labors of Jurgensen, Immermann, Liebermeister and others, to enter into any long discussion as to the *rationale* and the propriety of the hydriatic treatment in high temperatures, and if the same be true of fever, in which the philosophy of its application is rather complicated ⁽²⁾, it is certainly true of the pathological state under consideration, namely: Heat stroke, in which the therapeutic indi-

(1) Quain's Dictionary of Medicine, art. "Sunstroke."

(2) Ziemssen's "Hdbuch der Allg. Therapie. Antipyr. Heilmethoden, von Liebermeister," p. 15.

cation is simple: rapid abstraction of heat. Naunyn thus clearly expresses himself on this point: "To avoid any misunderstanding on this point I refer to it again, and declare expressly and distinctly, that in heat stroke I regard the rapid cooling of the system with cold water an absolute necessity." (1)

My manner of following out the indication for treatment is related in the histories. The wet pack there referred to, in Cases 1 and 2, was as follows: A large muslin sheet was folded in its length and then in its breadth and wrung out of cold water; the naked child was wrapped in it, placed in its bed or cradle and covered with a blanket. The nurse or mother watched the sheet, and as soon as it became warm it was removed and replaced by another which had been meanwhile cooling in the water; and this procedure was continued until the temperature reached the normal.

I am so explicit on this point for the reason that my method of using the wet pack differs from the wet pack described by Winternitz (2) and by Liebermeister (3).

I preferred this method for various reasons mentioned in the paper entitled "Hydrotherapeutics," already referred to.

It is the method easiest of application. All who have had any experience with children know the difficulties attendant upon putting a sick child into a bath—and more especially a cold bath (it could have been done easily in Case 1, but, fortunately for them, all cases are not seen at so late a stage); what stratagems must be resorted to; what struggles must be sustained once the child is in the bath; what cries! all certainly not beneficial to the little patient.

In the wet pack the child feels so comfortable, and this added to by the horizontal position which it can maintain, that the *bien aise* felt is expressed in the countenance, and it is only when the pack becomes warm that the child cries and shows any uneasiness.

But a more cogent reason is this: that I believe the wet pack as here described is a more powerful agent for the abstraction of heat than the cold bath.

It is true that the cold bath produces a marked and rapid lowering of the temperature, but this effect is not permanent, and in a longer or shorter period of time the temperature

1] Naunyn, Loc. Cit.

2] Winternitz, "Hydrotherap." Ziemssen's Handbuch der Allg. Therapie.

3] Liebermeister, Loc. Cit.

has again risen, and frequently to its previous height. The cold bath must then be repeated. ⁽¹⁾

En parenthese, it is a question that has presented itself to me, whether these shocks to the system, and undoubtedly there are ⁽²⁾, consequent upon the use of the cold baths, of depression and elevation, depression and elevation, may not have some deleterious action upon the organism.

The wet pack does not produce so rapid a depression of the temperature; but, on the other hand, if applied as here detailed, it is not followed by a reëlevation; the heat is abstracted gradually but continuously, and in the time required for this gradual abstraction the system can accommodate itself to the changed condition.

In Cases 1 and 2, in which the temperature was very high and at a dangerous point, in the one 106° and in the other nearly as much, and in which as large and as rapid an abstraction of heat as possible was indicated, I applied the wet pack to the whole body, as already described. In Case 3, however, in which the temperature was but 103°, and no immediate danger threatened, I used only the limited pack, *i. e.*, a heavy towel folded 3 or 4 times, wrung out of ice water, and applied to a limited portion of the body—in this instance, the head. I believed that the chief source of trouble lay in the great heat reflected from the ceiling upon the head of the infant, and hence it appeared to me that the therapeutic indications, *viz.*: an obviation of the cause and abstraction of the heat already absorbed, would be accomplished by the limited wet pack upon the head. The result, as already stated, was all that could be desired.

It will be observed that whilst in the general wet pack I used only the ordinary hydrant water, in the limited wet pack I resorted to ice water, thereby greatly enhancing its cooling powers.

From all that has been said, from the careful study of the symptoms, and a careful comparison of them with the phenomena produced in the experimental studies of heat effects, from a study of the etiological conditions and from the results obtained by the special treatment, I believe myself justified in claiming that "heat stroke" or "thermic fever," as resulting from overheated apartments, must have a place in the category of the summer diseases of infants. Though I have seen but the few cases recorded here, it can not be

(1) Liebermeister, *Loc. Cit.*

(2) As this is not the place to go into this in detail, I will only mention the rigors that accompany the elevation.

doubted that many more have occurred, and do still occur, every summer in the larger cities, wherein a great part of the population dwells under conditions as unfavorable as those referred to in the etiological section of this paper, or even more so; for it certainly is not to be supposed that mine were the only cases that occurred; but they have hitherto remained unrecognized, being engulfed in that great vortex that is made to swallow so many things, to wit: cholera infantum.

The importance of the recognition of the fact that heat stroke is of more frequent occurrence than has hitherto been believed, and that it may be produced by the heat of the apartments, is not to be underestimated—more especially as from their symptomatology these cases are apt to deceive. Cases 1 and 2 present many analogies to cholera infantum, and would be declared to be such by the majority of practitioners. It is a fact that most cases of vomiting and diarrhoea occurring in infants in the summer months are set down as cholera infantum, and it is so taught in the books.

This accounts for my uncertainty as to the therapeutic measures to be resorted to in Case 1, for though this was a typical case of heat stroke, still my mind was so occupied with the previous history of vomiting and diarrhoea that I looked upon it as a case of cholera infantum *in extremis*, in which nothing would avail, and had it not been for some previous experience with the wet pack I should not have dreamed of resorting to hydrotherapy. And although a careful study of the case afterwards disclosed to me its true nature, nevertheless, when I encountered Cases 2 and 3 I was still in a state of uncertainty as to their true character. Cases like the third are apt to be mistaken for cases of cerebral disorder. In fact, in West, *Diseases of Children* ⁽¹⁾, we find a case of heat stroke from exposure to the sun, treated of under the head of cerebral congestion.

The recognition, therefore, of the true character of these cases when they present themselves to us is of vital importance to the little patient, for upon it will depend whether the correct and appropriate therapeutic measures will be resorted to for its relief or otherwise. If correctly diagnosed the proper measures (already indicated above) will be instituted and crowned with success, even in apparently desperate cases; if not, it will be dosed and medicated until death closes the scene.

(1) West, Lectures on Diseases of Children, Philadelphia, 1866, p. 48.

